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Educational Television Series 1968-69

Teachers' Guide

DEPT. OF EDUCATION
HISTORICAL COLLECTION

Science, Technology and Trades

SENIOR DIVISION

Educational Television Branch
ONTARIO DEPARTMENT OF EDUCATION
1670 Bayview Avenue, Toronto 17

SCIENCE, TECHNOLOGY AND TRADES

Senior Division

30 programs, 20 minutes each

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INTRODUCTION

Using the format of documentaries filmed at various factories, mills, and laboratories, this series gives practical meaning to classroom studies by showing on-the-job application of some aspects of the Science, Technology and Trades courses. The ten programs broadcast before Christmas are new productions; the twenty in the new years are repeated from the 1967-68 schedule.

The new programs will be of interest to all Science, Technology and Trades students, since the use of materials is indigenous to all technical disciplines. The examination of each material is in general terms; showing how man is able to tailor materials to suit his needs. All of the film is original footage, shot for the particular program. Many operations and processes are, to our knowledge, shown for the first time.

MATERIAL

PROGRAM 1

ALLOY TOOL STEELS

The purpose of this program is to show how operations involved in the manufacture of a metal part require the use of various types and grades of tool steel. The emphasis is on the tool steels used in dies.

PROGRAM CONTENT

This broadcast shows the step-by-step production of a particular type of tool steel (Keewatin A.I.S.I. 01) from raw materials to finished billet. The charging of the electric furnace is described in detail. Electric furnaces are used because of the need to produce a steel with minimal contamination of its internal crystaline structure. Impurities inherent in other production methods cannot be tolerated in a tool steel. Following the casting of the 01 into ingots, cogging presses reduce the ingots to desired billet size. Further reduction in cross-section is accomplished on the 8000 lb. forging hammer or on the 10-2 hand mill. (Tool steel can be rolled in small sections only.) Testing procedures (ultra sonic, etching, Brinnel Hardness, etc.) are shown as they occur in the production cycle. Extensive testing is carried out to ensure uniform structure and quality since the subsequent machining into dies constitutes many times the cost of the raw material. Flawed material could cause failure of the die and consequently considerable financial loss.

Three tool steels which are commonly used for restrike dies are discussed as possibilities for specification by a die designer. Note that steels are referred to by their A.I.S.I. or ASTM number rather than by their brand names. While brand names are still used to refer to tool steels, number designation is more accurate and acceptable in specifications. The die designer selects AISI 01 for a restrike die to be used to produce stainless steel wheel covers. A sequence follows showing the various machining and heat treating operations which transform the material into a finished restrike die. While the emphasis on the use of tool steels for dies is apparent in the program, a small sequence at the end of the program shows a few applications of high speed tool steels for cutting tools.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Introduce the idea that steels differ — that some steels must be harder than others to facilitate working or cutting the softer materials.
2. Discuss hardness, ductility, toughness, wear resistance, machinability.
3. Discuss the heat treatment of steels. (Note that the broadcast *does not* examine lattice structure etc.)

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the various systems of numerical specifications of steels. (AISI., ASTM., SAE., CSA. etc.) and the meaning of each designation.
2. Discuss the methods used to handle the hot steel. Why are ingot moulds cast iron? What types of steel would be used for the dies in the cogging press, the forging press, rolling mills?
3. Assign a research report on various types of tool steels. Perhaps assign specific problems and have students select the proper tool steel for the job.

PROGRAM 2

STAINLESS STEELS

The purpose of this program is to describe stainless steel and to examine its ever-growing applications. A single type of stainless steel is examined in depth.

PROGRAM CONTENT

This program opens with a sequence indicating the diversity of uses for stainless steels.

A stainless steel, nominal 17-7 AISI is selected as typical, and its use as the material for automobile wheel covers is introduced.

These scenes are followed by a step by step description of the production of stainless steel from furnace to finished strip. Quality control tests used during the production cycle, including x-ray spectrographic analysis, are shown. Slabs are produced by a continuous casting process and reduced to plate and strip by rolling mills (both hot and cold).

During the processes, the Olsen cup test for ductility is shown. Once the stainless steel is shipped to the customer the production cycle for the wheel covers is described in detail. Note that the dies produced from alloy, tool steel in Program 1 are used as the forming dies for the stainless steel piece part in this program.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the term "stainless" as applied to steel. Can this term be taken literally or would the term "corrosion resistant" be more accurate?

2. On the chalkboard list some of the applications of stainless steel.

SUGGESTED POST-VIEWING ACTIVITY

1. Discuss the manufacture of stainless steel as a "refining" process (Raw material is graded scrap, not pig iron.)
2. Compare stainless steel and other steels with regard to strength, ductility, toughness, corrosion resistance, colour, etc.
3. Note that chrome plating is used as a colour-matching device. Discuss the necessity of chrome plating the wheel cover.
4. Assign research reports on the applications of stainless steels.

PROGRAM 3

STRUCTURAL STEELS

The purpose of this program is to show how the characteristics of structural steels govern the choice of steel for specific applications. Structural steel in rolled shapes, plate, and roll-formed sheet is shown in building, transport and other applications.

PROGRAM CONTENT

Following an opening sequence demonstrating the variety of applications of structural steel, a single type is shown in a wide flange-rolled shape. As the rolled member is machined to form a finished column, the various constituents of a structural steel and the qualities they impart to it are discussed. The possibilities of reducing either cross-sectional area or overall dimensions through the selection of higher strength steels (as a weight-saving device) is discussed. This is followed by a sequence showing the production of steel plate for use in manufacturing hollow sections and roll-formed sections. The concluding part of the program shows some of the developments in the use of steel tube and steel cable in structural systems. The program contains several spectacular sequences which were filmed at the site of the Toronto-Dominion tower in Toronto. Throughout the film all required safety measures are emphasized. Please note that in these erection sequences the "lead" men *do not* wear safety belts. This is permitted under safety regulations, since the mobility of these skilled workers would be impaired by the belts. All other workers in hazardous locations *must* wear safety belts; "lead" men are the only exceptions.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the students to bring out their concept of "structural steel".
2. List the types and uses of structural steel. (Check list against those shown in the broadcast).
3. List the qualities required in structural steel on the chalkboard.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the physical properties imparted to structural steel by alloying elements.
2. Review the steel designation systems. (Include CSA and CISC).
3. Assign a research report on any of the topics introduced in the program.

PROGRAM 4

FUSION OF STEEL

The purpose of this program is to show how the welding processes have allowed designers more flexibility in the use of steel.

PROGRAM CONTENT

This broadcast shows the major welding processes which have contributed to the technology of permanently joining steel parts or members by fusion. While forge welding and oxy-acetylene welding are mentioned, the major emphasis in the program is on electric arc welding. Briefly the major developments in arc welding are described and applications in industry are shown for each type. The shielded metal arc process, Metal Inert Gas (MIG), involving continuous-feed wire electrode and a gas shield, submerged arc welding, spot welding, flash butt welding and electroslag welding are viewed. Oxyacetylene cutting, including some automated cutting machines, completes the group of techniques described. Emphasis throughout the telecast is on the freedom that welding has provided in the use of steel as a material.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the class to develop a list of techniques which were used in joining steel permanently prior to the nineteenth century. Point out the limitations imposed upon the material's usefulness by the lack of rapid, permanent, strong connections.
2. List on the chalkboard all the welding processes with which the students are familiar. Compare this list with those processes mentioned in the program.

SUGGESTED POST-VIEWING ACTIVITIES

1. Review the principles involved in the basic welding processes, oxy-acetylene and electric-arc. (This should not be necessary in the case of students who have studied welding).
2. Discuss some of the production welding processes shown in the program.
3. Explain any terms introduced in the program which may be unfamiliar to the student (e.g. inclusion, flux, inert gas, etc.)
4. Check the list made prior to the telecast. Note that Tungsten Inert Gas, though mentioned, is not described in the program since its principal use is in welding aluminum.
5. Assign a research report on any of the welding methods shown in the program.

PROGRAM 5

ALUMINUM

The purpose of this program is to show some of the properties, methods of handling and applications of aluminum.

PROGRAM CONTENT

The opening sequence of the broadcast introduces some of the physical properties of aluminum; lightness, strength, corrosion resistance, electrical conductivity and ductility. Each property dictates a specific use of production method.

This section is followed by a description of the processes involved in the preparation of aluminum for use by the fabricator. Casting, rolling and extruding of raw stock is shown. Both experimental and quality control tests are demonstrated in the laboratory.

The applications of ingots, tube, extruded structural and decorative shapes, strip and foil are shown in the fabricators' plants and various casting methods are shown as well.

SUGGESTED PRE-VIEWING ACTIVITIES

1. List on the chalkboard as many applications of aluminum as can be obtained from the students.
2. Possibly list the processes used to produce aluminum articles.
3. Discuss the reasons for the growth of aluminum production in Canada (e.g., no bauxite deposits of any magnitude, but enormous hydro-electrical development).

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the ductility of aluminum and its effect on the handling and utility of the metal.
2. Set up a formal debate comparing steel to aluminum. Which is the more useful metal? Perhaps limit the debate to a discussion of the utility of each in a particular field.
3. Assign a research report on one of the following topics:
   - the corrosion resistance of aluminum,
   - aluminum casting alloys,
   - structural aluminum alloys,
   - the production of aluminum.

PROGRAM 6

THE FUSION OF ALUMINUM

The purpose of this program is to demonstrate that the development of specialized welding techniques greatly increased the utility of aluminum.

PROGRAM CONTENT

This telecast describes various methods of welding aluminum. Particular emphasis is placed on the *Tungsten Inert Gas* (TIG) process. The nature of aluminum and the problems posed by its tendency to oxidize rapidly are discussed. A demonstration shows the difficulties incurred in attempting to weld aluminum by the gas oxygen process without the use of flux and the problems which arise when fluxes are used. Included are the problems of flux corrosion and the need for its complete removal following welding operations.

The second segment of the program shows arc-welding using flux coated electrodes. The disadvantages of this process are noted.

The significance of the TIG process in the growth of the demand for aluminum as a material is demonstrated, it is noted that the aircraft industries' demand for the extensive use of aluminum, spurred the rapid development of aluminum welding technology.

The program gives a detailed description of the TIG process. This section describes the shielding action of argon and helium gas, the role of the tungsten electrode and the action of the arc in breaking up the aluminum oxide on the surfaces of the metal. Attention is paid to the choice of welding current, AC or DC, the problems of arc re-initiation and the use of high frequency systems.

The program proceeds to examine the *Metal Inert Gas* (MIG) process as applied to aluminum and the opportunity is taken to contrast MIG and TIG.

The applications of TIG welding are shown in industrial production. Brief mention is made of resistance welding processes; spot, seam and flash-butt welding.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Perhaps review Program four, "The Fusion of Steel".
2. From Program five, develop the idea that since aluminum oxidizes rapidly on contact with the atmosphere, oxidation might present a great problem in the welding of this material.
3. Compare the melting temperatures of steel and aluminum. Have students look them up in *Machinery's Handbook* or *The Handbook of Chemistry and Physics.* This should establish the possibility of both gas and arc welding aluminum.

SUGGESTED POST-VIEWING ACTIVITIES

1. List the problems which arise in attempting to fuse aluminum, (perhaps during the program). Discuss the solutions to each problem.
2. Discuss the MIG process. In the case of aluminum, an inert gas is used.
3. Assign a research report contrasting the MIG and TIG processes.

PROGRAM 7

CONCRETE

The purpose of this program is to show the importance of concrete as a building material by illustrating its composition, properties, and applications in modern construction practices.

PROGRAM CONTENT

Concrete is introduced as an extremely useful material for building and paving. The constituents of concrete are described in detail; portland cement, fine and course aggregates and water. Each constituent is

examined individually and then combined in a table-top demonstration to form concrete. The demonstrator is a student. The student performs a series of tests on the concrete including aggregate silt tests, a simple water purity test (generally, potable water may be used in concrete) and a standard slump test. The production of cement is described briefly. This initial sequence is reinforced in the field, at a concrete mixing station and at a building site. A comprehensive series of quality control tests is shown.

These are carried out at the Ontario Department of Highway's Laboratory. While there are brief segments throughout the program devoted to form work, reinforcing and pre-stressing of concrete (those processes involved in the placing of the material) the program's main concern is with the material itself.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the class to discover the principal ingredients of concrete.
2. List the advantages of concrete construction, (i.e., easily placed, takes any shape, etc.)

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the purpose of aggregates.
2. Discuss the purpose of cement. What is the function of gypsum in cement?
3. Discuss the compressive strength and tensile weakness of concrete. How is this weakness in tension overcome in practice?
4. Assign a research report on any of the following topics:
   - the production of cement,
   - pre-stressed concrete,
   - pre-cast concrete curtain walls,
   - concrete as a paving material.

PROGRAM 8

STRUCTURAL TIMBER

The purpose of this program is to show how laminated and other types of timber construction are used in the building industry. Emphasis is on the fabrication of laminated timber.

PROGRAM CONTENT

A brief historical sequence on timber as structural members of buildings introduces this program. The development of laminated timber by Hetzer, the German railroad structural engineer at the beginning of the century, emphasizes two points. Wood is relatively corrosion resistant and the lack of large trees in Europe suitable the solid timber members engendered glued laminated timber. The advantages of laminated timbers is explained in detail. This opening is followed by a sequence showing how laminates for beams are glue-coated, laid up by hand and clamped in jigs. This method is still used in the production of curved members. While some special section straight members are still produced using scarf-joining of laminates, jigging, clamping, and air curing, *recent Canadian developments* have revolutionized the production of laminated structural timber. The *only* hot press in the world capable of producing extremely large laminated beams *automatically,* was developed in Vancouver, B.C. A complete description of this process is given in the program. Other new developments such as G.P. frames, HB beams and *Glulam* rivetted connections are included in the body of the program.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the reasons for the decline in the use of large sawn timber and stone after the advent of steel and concrete as building materials.
2. Discuss any local building having laminated structural members (e.g., a church, shopping centre, arena, curling rink or service station). Why was wood used? Why laminated rather than sawn timber?
3. By questioning the students examine the advantages and disadvantages of *timber* construction.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss in detail the structural frame systems involved in GP frames. (A force diagram might be put on the chalkboard).
2. Discuss the advantages of laminated beams over sawn timber under the following headings:
   - effect of water content on the strength of the member,
     water content in *a tree* 45% approx.,
     water content in *large timber* 25% approx.,
     water content in *laminate 10%* approx.,
   - fire resistance,
   - economy,
   - availability.
3. Assign research reports on:
   - finger-jointing,
   - laminate glues,
   - automatic hot press laminating. (Information is available from manufacturers).

PROGRAM 9

THERMO SETTING PLASTICS

The purpose of this program is to describe thermosetting plastics; their properties, manufacture and uses.

PROGRAM CONTENT

The opening sequence describes the basic difference between the two *families* of plastics – *thermosetting plastics* and *thermoplastics.* This is followed by a brief description of the five most common groups of thermosetting plastics; *polyesters, epoxies, phenolics, amino plastics* and *polyurethanes.* An application of each type is shown. A more detailed approach to polyesters in a laboratory situation follows the introductory part of the telecast. Analysis and testing techniques used in industry are shown. The balance of the program describes various production techniques which have been developed to utilize the peculiar characteristics of the various thermosetting plastics. This includes the use of wood flour and other fillers in phenolics; glass or sisal fibers in

mixes; and glass matting, roving, and continuous filament with polyester resins.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Point out to the students that plastics are man-made materials.
2. Point out that plastics were initially developed as substitutes for traditional materials—many synthetics are superior to the original material — nylon for women's stockings for example.
3. With senior students a discussion of the chemistry of polymers might be conducted.

SUGGESTED POST-VIEWING ACTIVITIES

1. An analogy which may help the students to differentiate between thermoplastics and thermosetting plastics is this:
   a) An ice cube in a tray behaves like a thermo plastic. If heat is applied it becomes a liquid. If it is recooled it becomes a solid once more. This process may be repeated as many times as desired. The application of heat reduces the solid to a soft or liquid state.
   b) An egg which is hard-boiled behaves as a thermosetting plastic. Once heat is applied the gelatinous egg becomes solid and no amount of cooling or heating can return it to its former state.
2. Discuss in detail the five main families of thermosetting plastics. Have the students try to list common articles or materials which belong to each family.
3. Assign a research report on:
   — plastics as substitute materials,
   — thermosetting plastics,
   — production processes used to produce thermosetting plastic articles.

PROGRAM 10

THERMOPLASTICS

The purpose of this program is to describe thermoplastics; their properties, manufacture and uses.

PROGRAM CONTENT

The program opens with a brief review of the differences between thermosetting plastics and thermoplastics. This is followed by a brief description of the main materials in the thermoplastic family. Each type is used to demonstrate how their unique chemical or physical properties dictate their practical applications. Polythylene, polypropylene, polyvinylchloride, polystyrene, ABS, nylon, cellulosics and acrylics are some of the thermoplastics described. The final portion of the program shows various production processes used to manufacture thermoplastics goods; extrusion, injection molding, blow-molding, rotational molding and thermoforming.

The program closes with a description of a computer program in use at the Polymer Corporation wherein all information on the chemical and physical properties of various plastic formulations is held in the computer. When a customer desires particular qualities in a plastic, these specifications are programmed into the computer which feeds out feasible formulations to meet the specifications. Thus a new variation of a plastic can be *custom-made* for the industry.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Review Program nine with emphasis on the difference between thermosetting plastics and thermoplastics.
2. Have the students attempt to list some thermoplastics. Perhaps suggest that they consider some common plastics which were not included in Program nine, e.g., polyvinylchloride, nylon, polystryrene.
3. Point out that the major raw material of plastics is petroleum.

SUGGESTED POST-VIEWING ACTIVITIES

1. Complete the list of thermoplastics on the chalkboard. Attempt to list a common use for each type and establish the reason for the application.
2. Select one or two of the plastics and attempt to list the various forms in which it is manufactured. Polyvinylchloride is an excellent example. It is used in rain wear, phonograph records, upholstery, wire covering, pipe, garden hose, flooring, etc.
3. Discuss the computer program instituted at Polymer Corporation for the retrieval of formulations for plastics to suit particular needs.
4. Assign a research report on any of the common thermoplastics.
5. Assign a research report on any of the molding or forming processes used in the manufacture of thermoplastic products.

INDUSTRIAL CHEMISTRY

PROGRAM 11

THE TECHNICIAN

The purpose of this program is to show chemistry in industry and to explain the duties of the chemical technical worker.

PROGRAM CONTENT

The broadcast opens with a humorous explanation of the benefits of chemistry enjoyed by our society. The three main areas of activity in chemistry; research and development, quality control, and technical services to the customer, are examined. Case studies of three young people, of diverse educational backgrounds, are presented. Each of the young people shown explains in his or her own words one facet of his or her job and area of responsibility in the chemical laboratory or plant. These case studies demonstrate that learning must continue beyond formal education. In-service courses sponsored by The Association of Professional Engineers and The Chemical Institute of Canada, are mentioned as a means of upgrading the technician after he has begun work.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Ask the students to name products which *do not* involve chemistry directly or indirectly. This negative approach may serve to demonstrate the importance of chemistry in industry.

2. List on the chalkboard the three main groups of chemical laboratory workers: chemists and chemical engineers, chemical technologists, and chemical technicians.

3. If possible, suggest to grade ten students that they have their parents watch the telecast, particularly if a course in Industrial Chemistry is offered at your school.

SUGGESTED POST-VIEWING ACTIVITIES

1. With reference to the chalkboard list, discuss the educational background required for each group of chemical workers.

   Point out the various ways of acquiring certification in each area. (C.I.C. courses, ATEC courses, formal education at university and Colleges of Applied Arts and Technology. This information should be available from your Guidance Department).

2. Introduce the recommended Industrial Chemistry Course entrance requirements at your school; proficiency in Mathematics, Science, and English.

PROGRAM 12

HERE'S HOW

The purpose of this telecast is to explain the Industrial Chemistry Course in the four or five year Science, Technology and Trades program and to demonstrate its value as a basis for further formal study or for employment in industry.

PROGRAM CONTENT

The first half of the telecast shows student activity in an *Industrial Chemistry* classroom and laboratory. An explanation of the course content is made by showing students performing routine tests in the laboratory. Emphasis is placed on the fact that much of the activity is carried out by the students without the participation of the teacher. Safety is emphasized throughout.

The second half of the telecast shows that the advancement of instrument technology has transformed much of the work in the chemistry laboratory from wet chemistry to instrumental chemistry. The major modern instruments for chemical analysis are shown in use in the research department of a major oil company. Each instrument's function, operation and cost is mentioned. It is hoped that by emphasizing the cost and complexity of the instruments, the student will be convinced that the chemical technologist must be a skilled and responsible worker. Additional skills and knowledge above a basic knowledge of chemistry, are required by most chemical laboratories. An examination of the elaborate pilot plants which are assembled by the chemical technicians demonstrates their need for manual dexterity and mechanical aptitude.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss briefly program eleven to emphasize the opportunities available to the student who majors in *Industrial Chemistry.*

2. List on the chalkboard the instruments which will be shown in the analytical laboratory.
   - the Mass Spectrometer,
   - the Nuclear Magnetic Resonance machine,
   - the X-Ray Diffraction and Fluorescence equipment,
   - the Infra red Spectrometer,
   - the Electron Microscope.

   Note: The gas Chromatograph was explained in program eleven. It might be added to the list.

3. Point out that the work of an analytical laboratory is essentially *detective work.* The graphical, film, and digital readouts produced by the analytical instruments provide *fingerprints* which identify materials or their components.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the differences between *Industrial Chemistry* as a *technical* subject and the *regular* chemistry course offered to all technical students.

2. Discuss in detail the extra skills which a chemical technician or technologist requires. Possibly list these on the chalkboard.

3. Discuss in detail the function and operation of the analytical instruments shown in the telecast. (For Industrial Chemistry majors).

AUTOMOTIVE TECHNOLOGY

INTRODUCTION

This group of five programs is not an integrated series, although the programs are to a degree complementary. Once again the format is documentary. The treatment is purposely less formal than the preceding series. We hope that this will provide some variety for the students, while aiding us in establishing a format to use in presenting technical topics in the future. While the content of the programs may encompass some basic lessons in the Course of Study, the programs provide a basis for expansion by the teacher beyond it. The last two programs involve the use of the dynamometer as a practical diagnostic tool. An attempt was made to generalize on its operation because of the differences in the equipment of various manufacturers. Since the principal differences seem to be in the type and operation of the power absorption unit, the most common types are included.

Because of the complexity of the many diagrams used in this series optimum viewing conditions as recommended must be established.

PROGRAM 13

GASOLINE

This program examines the most common engine fuel — gasoline, its physical and chemical properties, and its resulting behaviour in use in the internal combustion engine.

PROGRAM CONTENT

The opening sequence of this program

demonstrates the need for vast quantities of gasoline as fuel for internal combustion engines in a variety of vehicles. This is followed by a brief explanation of fractional distillation of crude oil. It traces the sequence of production from the arrival of the crude oil at the refinery to the retail distribution of the product. In consequence of this, the chemical additives to the gasoline are examined as agents used to prevent engine "knock", etc. The operation of the four-stroke internal combustion engine is explained briefly. Common combustion faults such as detonation and pre-ignition are explored as to cause and effect. The program emphasizes that gasoline is a safe, convenient fuel if it is handled with sensible care.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the class as to the most common motive power in use. (This should lead to the internal combustion engine.) Establish the most common fuel used in internal combustion engines.
2. Establish the source of gasoline. Perhaps question the students to develop a concept of the refining process.
3. Discuss the necessity of additives to gasoline.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the refining of crude oil. Establish and correct, if necessary, the students' concept of fractional distillation, cracking (both thermal and catalytic) tetra-ethyl lead and the detergent additives. Note the care exercised in handling tetra-ethyl lead.
2. Explain that most additives are supplied to the oil companies as a single blending stock by the Ethyl Corporation or other chemical suppliers. The basic differences between gasoline brands lie in the additives, rather than the gasoline stock.
3. Discuss detonation and pre-ignition as to the causes, and damaging effects on the engine. Try to establish the difference between spontaneous detonation and pre-ignition due to *hot spots* in the combustion chamber.
4. Note that the term *octane* is not explained in the program. Possibly assign a homework question on this topic.
5. Discuss safety measures which should be observed in the handling of gasoline.
6. Assign a general research report on the oil refining process or smaller, more detailed reports on individual processes, e.g. catalytic cracking, reforming or isomers.

Note: A wealth of literature is available from the major oil companies which can be used as source material for research reports.

PROGRAM 14

CARBURETION AND THE FUEL SYSTEM

This program shows the preparation and control of the air fuel mixture and its flow to the internal combustion engine.

PROGRAM CONTENT

Through the media of film and limited animation the function of the carburetor is explained in detail. Each of the six major carburetor circuits is shown: the float circuit, the idle and low speed circuit, the high speed circuit, the accelerator pump circuit, the power circuit and the choke circuit. Fuel injection, multiple carburetor and multi-barrelled carburetor systems are introduced. The summation of the program traces the fuel's path from gasoline tank to the exhaust of unburned gases.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Review the characteristics of gasoline. Stress the necessity of an air fuel mixture in order to produce an explosive (sic. rapid, even-burning) mixture in the combustion chamber.
2. Demonstrate carburetion. A perfume atomizer may be used to show the mixture of air and fuel. (This more closely resembles fuel injection since the bulb acts as an air pump.)
3. Ask the class to list the main elements of the fuel system on the chalkboard.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the *Bernoulli principle* and its application in the venturi of the carburetor.
2. Review the six carburetor circuits briefly.
3. Have the students explain each of the elements of the fuel system which were listed on the chalkboard prior to the telecast.
4. Assign a research report on one of these topics:
   a. Explain with diagrams any one of the six carburetor circuits. (Grade 10 if applicable),
   b. Multiple-carburetion — advantages and disadvantages,
   c. Multi-barrel carburetion — advantages and disadvantages,
   d. Fuel injection — advantages and disadvantages,
   e. The Electric fuel pump vs. the Mechanical pump.

PROGRAM 15

HEAT ENGINES

This program shows that the energy generated by burning fuels, used to expand air, or gas, provides a power source for all heat engines.

PROGRAM CONTENT

The program opens with a brief historical examination of heat engines. The heat engine is defined as a mechanism which changes heat energy into mechanical energy. The elements of a heat engine are a source of heat (burning fuel) an expanding medium (air or gases) and a mechanical device which utilizes the expanding medium to produce rotary or reciprocating movement. Each of the common heat engines is examined: the internal combustion engine, steam engines, the steam turbine, the diesel engine (both two-and four-stroke types) gas turbine engines (both jet and turbo prop) and the free piston engine.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the operation of the internal-combustion engine to establish that the hot expanding gases and air resulting from the burning of the fuel, provide the motive power of the piston. Establish that the internal-combustion engine is a heat engine; then ask the students to name some other heat engines. Possibly list these on the chalkboard.

2. Discuss various fuels which might be used to produce heat in heat engines. List these on the chalkboard.

SUGGESTED POST-VIEWING ACTIVITIES

1. Review the historical development of the various heat engines.

2. Examine each of the heat engines and their fuels, using the lists made up on the chalkboard prior to the program. You may wish to add nuclear-fission as a source of heat to drive steam turbines.

3. Discuss heat engines which were not included in the telecast, (e.g. the Wankel Internal-combustion engine).

4. Discuss the thermal efficiency of heat engines. Possibly assign a research report on this topic.

5. Possibly discuss Charles' Law as applied to the diesel engine.

Note: an excellent pamphlet, "The Story of Power" is available from the Public Relations Staff of General Motors Ltd., Detroit 2, Michigan, U.S.A.

PROGRAM 16

THE MEASUREMENT OF HORSEPOWER

This program defines horsepower and demonstrates how it may be measured.

PROGRAM CONTENT

James Watt's experiment is described in which he established a standard measure of horsepower by the empirical method. A simple problem is used to demonstrate how horsepower is calculated, based on Watt's formula. This is followed by an examination of the *Prony brake* as a laboratory apparatus to measure the horsepower produced by relatively low-power rotating mechanisms. The formula which utilizes the information obtained through the use of the *Prony brake* is developed. The engine dynamometer is introduced as a means of measuring the horsepower output of high-powered engines. The generator type engine dynamometer is shown to use the generator as an absorption unit, being driven by the engine under test. The electrical output of the driven generator in watts, can be translated into brake horsepower. The water-brake dynamometer which employs a hydraulic absorption unit is described in detail. Both types of torque arm linkage, weight scale arm and electrical bridge, are also described.

The last segment of the program explains the use of the chassis dynamometer to measure the efficiency of the power train, that is, the horsepower delivered to the driving wheels of the vehicle.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the meaning of the term *power* in relation to *work.* Explain that *power* is a measure of the rate of doing work. Establish that *horsepower* is a unit of power, that is, a specific amount of work done in a specific time. Power equals work x time *or* since work equals load x distance, power equals load x distance x time.

2. Question the class to establish why the measure of power is called *horse*power.

SUGGESTED POST-VIEWING ACTIVITIES

1. Review the concept of *power.* Possibly demonstrate Watt's formula with a simple problem.

2. Explain the term *torque.* Show how the *Prony brake* and the water absorption unit of the dynamometer utilize the turning movement of the *torque arm.*

3. Explain the difference between the various horsepower ratings of engines (e.g. brake horsepower, SAE horsepower, and licence horsepower).

4. Demonstrate the measurement of horsepower on the automotive shop dynamometer if available.

5. Assign a research report on the various makes of dynamometer; (e.g. Maxwell, Clayton, Bear, etc.), with particular emphasis on their absorption units.

PROGRAM 17

APPLICATION OF THE CHASSIS DYNAMOMETER

This program demonstrates the use of the chassis dynamometer as a simulator which in conjunction with other analytical instruments provides an effective means of trouble diagnosis in the automotive shop.

PROGRAM CONTENT

The opening sequence demonstrates that to be sure that an automobile is functioning properly a diagnosis on a dynamometer is much safer than a road test. The program shows step by step how the performance of a vehicle can be checked and faults located and corrected under "road test" conditions in the automotive shop. This is accomplished through the use of the roll-type chassis dynamometer and its auxiliary instruments. Standard tests are explained as they are carried out by mechanic-technicians. Some of the tests are explained in detail while others are given a more cursory treatment. It should be noted that some of the tests will vary with the capability of the equipment available from a variety of manufacturers. However, an attempt has been made to emphasize those tests which may be carried out using common types of equipment available in industry and the automotive classroom.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the students to generate the idea that the roll-type chassis dynamometer might be used to duplicate road conditions in the automotive shop.

2. Discuss the *diagnostic centres* as a

recent development in the automobile service centres. Introduce the chassis dynamometer as the principal equipment used in these centres.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the relative merits of road testing and dynamometer testing of vehicles. Emphasize safety.
2. Discuss in detail the various standard tests which may be carried out using the chassis dynamometer and allied equipment. (Information is available from any analytical equipment manufacturer.) Emphasize the function of the dynamometer as a simulator.
3. Arrange a tour of a local diagnostic centre and assign a research report of the tour.
4. Demonstrate the use of the dynamometer and its auxiliary instruments in the automotive shop. Point out the differences (if any) in your equipment from that shown in the telecast. Discuss the relative merits of each type.

ELECTRICAL TECHNOLOGY

INTRODUCTION

As the titles of the programs prepared on *Electrical Technology* indicate, this group of telecasts does not constitute a series. Each program deals with a single topic which should prove of interest to technical students. They were filmed on location at various factories, and laboratories. The programs are diverse because they are attempts to present individual topics which are somewhat difficult to present in the classroom. Program 18 and 19 *(Microcircuitry and Numerical Control Systems)* will require considerable preparation by the students and careful attention during the telecasts. Both of these subjects are relatively difficult to understand without prior instruction. They are suitable for Grade 11 and 12 technical students. Program 20 will be beneficial to all grades.

PROGRAM 18

MICROCIRCUITRY

This program explains the meaning of microcircuitry and shows the development, applications and advantages of micro-miniaturized circuits, with particular attention to micromodules, thin films and integrated circuits.

PROGRAM CONTENT

The initial sequence in this program points out the advantages of microcircuitry: cheap and easily obtained materials, mass production fabrication techniques, mobility, portability, limitation of environmental stresses due to size, extremely rapid interaction of components, reliability, efficiency, function life, the possibility of incorporating redundant circuits without an appreciable increase in size, and finally, a reduction in cost. This sequence is followed by simple descriptions of micromodules, thin film and integrated circuits. The basic steps in the manufacture of these components are shown with the greatest emphasis on integrated circuits.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the terms
   - single discrete component transistor
   - micro-miniaturization
   - micro-module
   - integrated circuit
   - redundant (or back-up) circuits
2. Explain *diffusion, sputtering,* and *photo engraving.*

SUGGESTED POST-VIEWING ACTIVITIES

1. Recall specific advantages of miniaturization.
2. Distinguish between micromodule (stacked), thin film (deposited), and integrated (photo engraved and diffused).
3. Discuss the effect of integrated circuits on the knowledge and technical activities of the technician. Perhaps assign an essay on this topic.

PROGRAM 19

NUMERAL CONTROL SYSTEMS

The purpose of this program is to describe and explain numerical control systems, and to investigate a typical unit used to control a machine tool.

PROGRAM CONTENT

Numerically controlled machines are presented as a unit not restricted to mass production, designed instead to do small-lot precision work. The advantages of numerical control of machines are examined in some detail. The development of numerical control is traced from Joseph Jacquard's punch card controlled weaving machine through the player piano to the beginning of modern numerical control at the Massachusetts Institute of Technology in 1952. The basic units of a numerical control unit: the decoder, the information storage, the servo units, gauging devices and feed back comparator, are examined and their functions are explained. Basically, input, central processing unit, and an output are the components of the numerical control unit.

Tape readers or sensing devices of various types are mentioned but the punched paper or "mylar" tape unit is examined as typical. The examination of a program prepared from drawings or specifications, its translation to eight column tape, and its eventual use in the control unit activating the servo-systems which regulate the movements of the machine-tool platen or spindle, completes the telecast.

SUGGESTED PRE-VIEWING ACTIVITIES

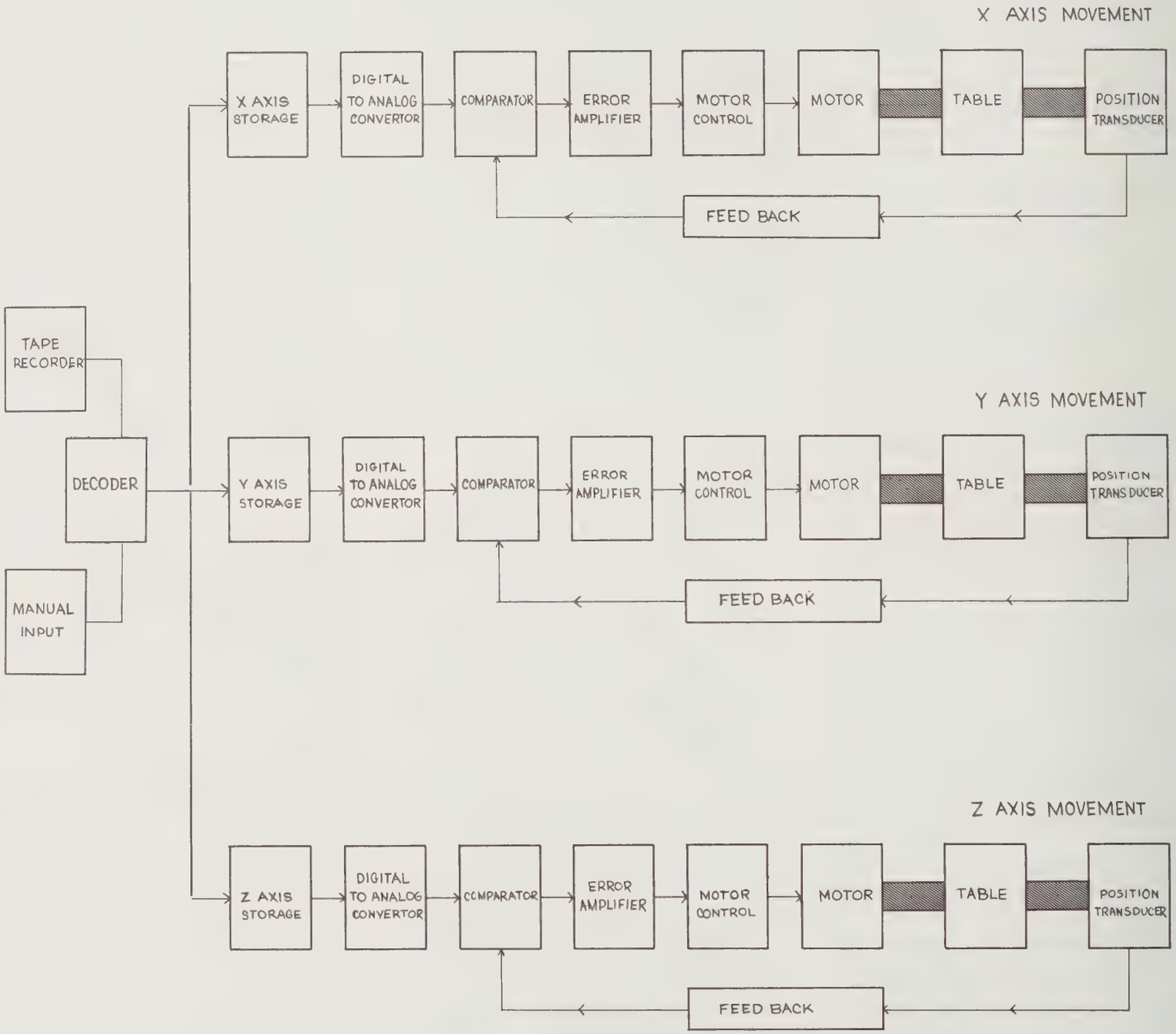
1. It is essential that the students understand the *binary system* in mathematics if they are to understand the basic concepts of the content of this program. *This system should be reviewed prior to the program.*
2. Discuss bistable devices as incorporated in computers.
3. Perhaps place an unlabelled block diagram of a simple numerical control

system on the chalkboard to be labelled by the students after viewing the program.

SUGGESTED POST-VIEWING ACTIVITIES

1. Complete the block diagram shown below.
2. Initiate a discussion on the rate of introduction of numerical control systems in the manufacturing industry. *If* it is generally conceded that the rate is *slow* try to establish the reasons for this.
3. Assign a research report on either the numerical control system or its individual components. Perhaps have the best reports presented to the class as papers. Insist that the students be prepared to answer questions from the class.

Simplified block diagram of a typical Numerically Controlled Machine



PROGRAM 20

LABORATORY SKILLS

This program demonstrates that the laboratory skills developed in the school are identical with those required by industry.

PROGRAM CONTENT

This program compares the laboratory skills practiced in school by a student, with those required upon his graduation and subsequent employment as a technician in industry. The areas of employment requiring skilled technicians are mentioned. The skills of the technician are outlined and related with those which should be learned in the electrical classroom. These include physical dexterity, the utilization of technical knowledge, the ability to communicate both orally and in written reports, and to work effectively while observing good safety practices.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Question the class to obtain the students' concepts of laboratory skills. Possibly list these on the chalkboard. It might prove interesting to list other qualities expected in industrial technicians, e.g. integrity in recording results, attitudes etc.
2. Attempt to list the areas of employment where electrical laboratory skills are required, e.g. research, inspection, quality control, etc.

SUGGESTED POST-VIEWING ACTIVITIES

1. Examine the list on the chalkboard to compare those skills listed with those mentioned and demonstrated in the telecast.
2. Discuss the format which should be used in preparing a technical report. Perhaps have the students develop their own formats in writing up a simple experiment. The reports should be presented to the class upon completion for critical examination by fellow students.

INDUSTRIAL PHYSICS

INTRODUCTION

The two programs on industrial physics are closely integrated and it is recommended that both should be viewed and in sequence. While the aircraft industry is used as a rich example of how physical principles are evident, not only in production but also in the machines of production, it should be emphasized that physics is applied in *all* industries. Even the simplest apparatus or machines inevitably involve physical concepts and laws.

PROGRAM 21

APPLIED PHYSICS IN INDUSTRY – PART I

The purpose of this program is to introduce the Industrial Physics Course and to show that applications of physical principles permeate industrial activity.

PROGRAM CONTENT

The opening sequence describes the four main divisions of activity incorporated in the Industrial Physics Course of Study: *Mechanics of Materials, Hydraulics and Pneumatics, Instrumentation* and *Electricity.*

This is followed by several sequences describing the testing and examination of materials used in the fabrication of aircraft. Many of these tests are carried out by the metalurgical technologist in the Quality Control Laboratory. X-ray and ultra-sonic apparatus is shown being used to check both raw materials and fabricated parts.

Hydraulic and pneumatic actuated tools and instruments are examined. Finally, a leak test on a wing tank is shown.

SUGGESTED PRE-VIEWING ACTIVITIES

It is suggested that the teacher point out to the students the following:

1. *Physics* is the basic science and therefore one should expect to find physical laws operating in every piece of hardware—from plumbing fixtures to space vehicles.
2. The limitations of technology are really the limitations of our knowledge of materials.
3. Fifty per cent or more of the production machines are equipped with fluid power, either hydraulic or pneumatic.
4. Instrumentation involves both measurement *and* control. For example, closed-loop systems involve the sensing and control of physical processes.
5. There is a great demand in industry today for people who can work intelligently with a wide range of electro-mechanical devices which are inherent in any automated or semi-automated process.

SUGGESTED POST-VIEWING ACTIVITIES

Since this program is intended to introduce the subject *Industrial Physics* to Grade ten students, with a limited background, the teacher may choose to limit the post-viewing activity to a discussion of the program content. Possibly a review of the Industrial Physics Course content might be made.

PROGRAM 22

APPLIED PHYSICS IN INDUSTRY – PART II

The purpose of this program is to show further examples of the application of physical laws and concepts in industry.

PROGRAM CONTENT

Whereas program twenty-one showed tests involving physical principles being carried out during the production of aircraft parts, this program shows many destructive tests carried out on the members of finished aircraft. These tests simulate actual flying conditions and subject the parts to the most rigorous activity possible. Wings are vibrated, loaded, and

flexed continually until failure occurs. The program shows fatigue tests on the principal airframe parts as well as drop-tests of landing gear. All these tests are carried out to ensure the complete safety of the aircraft. A brief examination of some of the aircraft instrumentation completes the telecast.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Review the Course Content headings of the Industrial Physics Course.
2. Emphasize that while the aircraft industry is used as an example, the applications of physical principles are evident in all industries.

SUGGESTED POST-VIEWING ACTIVITY

A discussion of the program content with emphasis on the physical laws and concepts demonstrated in the program should suffice.

CONSTRUCTION TECHNOLOGY

INTRODUCTION

This group of programs serves as an overview of the largest and most complex industry in Canada—the construction industry. The emphasis throughout the series is on heavy construction, as opposed to single dwelling or house construction. The programs show successively the stratification and multiplicity of employment opportunities among the work force, the components of a large project and the methods used to build it.

PROGRAM 23

THE CONTRACTOR BUILDS

The purpose of the program is to explain the work and responsibility of the general contractor in the construction industry.

PROGRAM CONTENT

The program opens with an explanation of the procedure of *calling for tenders.* It outlines briefly the steps and personnel involved in the preparation of a *tender.* The relationship of the *sub-contractors* to the general contractor is explained. Once the contract is awarded, the contractor's *building team* is organized, and a detailed work schedule is drawn up. The balance of this program is devoted to an explanation of how the site is prepared, the excavation staked and dug, the footings poured, the foundation wall forms erected, and how the foundation walls are reinforced and poured. A cursory examination is made of the types of pilings and caissons commonly used in foundations.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Have a few newspapers available listing calls for tender. These could be examined and discussed by the class. Emphasize bonding required and closing dates. Point out that calls for tender are not always posted in newspapers.
2. Discuss building contractors. Question the class to discover what are their opinions about the contractor's duties and responsibilities on a large job. Why are sub-contractors used?

   Possibly list the area of responsibility of the general contractor on the chalkboard.
3. Suggest that the students should watch for indications that good safety devices and clothing are used on the building sites shown. (Hard hats are worn by all workmen and supervisors on the sites.)

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss a building contract. Who are the contracting parties? Drawings and specifications become legal addenda to the contract. What are penalty clauses, bonus clauses, and contingency funds? Possibly discuss insurance and bonding procedures.
2. Discuss the personnel of a contractor's *building team.* Emphasize the roles of the superintendent, the engineer, the carpentry foreman and the labor foreman. Point out that *most* superintendents begin as carpenters. Since the carpenter works with all other trades, he has a good knowledge of the work procedures employed in all phases of construction.

PROGRAM 24

THE STRUCTURE

This program explains the function of each of the basic components of a building structure.

PROGRAM CONTENT

Emphasis is placed upon methods of reinforced concrete construction to the exclusion of structural steel. This approach enables a detailed examination of the work of the carpenter in building formwork. Each basic building component is examined. Reinforced concrete columns, both pre-cast and poured on the site, are shown as the principal vertical supporting members of the structure. Beams of various types are shown. The placement of reinforcing is explained. The theory of pre-stressing in beams and slabs is explained briefly. Various types of slabs are shown. The form-work necessary to support the suspended type of slab is explained in detail. Lift-slab construction is not shown or discussed.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the three principal materials used for the structure or skeleton of a building: wood, structural steel, and reinforced concrete.
2. Explain the chemical composition of concrete and the advantages gained by its use, e.g. fireproof; can be cast to any shape; easily handled.

   Discuss compressive, tensile and shear strength of the concrete. Question the class as to why steel reinforcing is needed.
3. Have the class try to list the basic

members of a building's structure. Perhaps list these on the chalkboard: columns, beams, and slabs.

If possible, list the types of each basic component.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss in detail the placement of reinforcing rod in concrete members.
2. Discuss pre-tensioning and post-tensioning of cables in pre-stressing concrete members. In reviewing the concept of pre-stressing, the principle can be easily demonstrated with a flexible stick, a piece of string and a weight.
   a. Support the stick at each end and place the weight in the centre. The wood sags.
   b. Fix the piece of string to one end of the stick, pull on the string until the stick bows slightly, and fix the free end of the string to the other end of the stick. Pluck the string to demonstrate that it is under tension. This causes compression of the stick.
   c. Place the weight on the stick once more. Note that the stick tends to straighten, but does not sag.

      The compressive stress induced by the string must be overcome before the weight can cause the stick to sag.

PROGRAM 25

READY FOR PEOPLE

The purpose of the program is to show the various finishing operations required to complete a building and the variety of specialist craftsmen involved.

PROGRAM CONTENT

The opening sequence presents the finished structure as the framework from which the electricians, plumbers, pipefitters and sheet metal workers hang the pipe, conduit and ducting which provide the essential services to all parts of the building. This is followed by a brief description of the preliminary and finishing work done by these trades plus the masons, bricklayers, lathers, glaziers, plasterers, painters, tile-layers and carpet-layers. The diversity of work done by the carpenter is emphasized. Where possible, modern techniques and materials are shown, but the traditional work of each trade is emphasized. Good safety practice is evident throughout the program.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Try to list on the chalkboard all the trades involved in a large building project.
2. Set up a simple schedule to be filled in after the program is seen.
3. Discuss the need for inspection. Try to list the various types of inspector.

SUGGESTED POST-VIEWING ACTIVITIES

1. Review list to add any trades not listed initially. Discuss the nature of the work of some of the trades to discover what type of training or education would be required for each.
2. Discuss the trend toward the use of prefabricated units requiring installation only. Emphasize that much of the installation of building units is done by carpenters.
3. List on the chalkboard the many jobs done by the carpenter.
4. Assign a major research project on safety practice within the construction industry. This should include regulations imposed by law, insurance companies and contractors.
5. Initiate a formal debate requiring organized preparation of the following (or on similar topics):
   a. The relative importance of any two trades (this should be controversial)
   b. The merits of structural steel construction versus reinforced concrete
   c. Theoretical knowledge versus practical experience as a requirement for supervisory work

MECHANICAL TECHNOLOGY

INTRODUCTION

INTRODUCTION TO MECHANICAL TECHNOLOGY

This group of five programs introduces some of the principles involved in the design and fabrication of a manufactured product. The product chosen is a Canadian non-consumer product — a tool — a chain-saw. It should be emphasized that this product is a typical example. Since all manufactured products are an attempt to satisfy a need, each evokes specific problems to be solved in design, production and marketing. Although the selection of a single product for study did impose limitation upon the scope of the investigation, the narrow concept allowed some study in depth. The chain-saw is complex enough to involve several industrial processes, and yet simple enough to be understood by the students. The programs should not be regarded as lessons on particular topics, but as an overview of the subject area. They are intended to stimulate interest, to create a desire on the part of the students for more information. Actual applications of production methods are shown which provide a basis for further study as the teacher desires.

PROGRAM 26

DESIGN OF A PRODUCT

The purpose of this program is to introduce the premise that a definite market demand instigates the design of a product. The requirements of the potential user, modified if necessary by the cost of production, plant capabilities, safety regulations, and materials available, establish the configuration and external appearance of the manufactured product.

PROGRAM CONTENT

The opening sequence of this program

establishes the need for the chain-saw as a practical means of increasing the efficiency of the forestry industry. The requirements of the operator for a light-weight, powerful, compact, rugged, and easily-serviced tool present the design team with their main problems. Although the design team is made up of many specialists within the company, outside consultants are frequently employed to do field research and time-motion studies. The many practical considerations growing out of the demands of the operator increase the complexity of the design problem. The gasoline tank must have a sufficient capacity to ensure a reasonable operating time without refuelling. The saw must be capable of operating under a wide range of temperatures. Forestry Department safety regulations require spark-arrestors, provision for filling the gas tank from regulation gasoline safety can, venting of the gasoline tank to prevent pressure build-up in hot weather, and a safety throttle lock. All these practical considerations and problems are compounded by the demands of the marketing department for a product which is cheap to make and yet has a good appearance. When all the problems of design have been studied through the use of sketches and prototype models, and solutions have been found, working drawings of the saw are made. The production cycle can now begin.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Examine a familiar object (a screwdriver, for example) to establish why it has a particular size, shape, colour; why particular materials are used. Emphasize that in general, most manufactured objects are designed to meet a particular need, and that the user influences the design. The screwdriver's size, shape and materials must enable it to be used efficiently by the man driving the screws. Its colour might be the result of a desire on the part of the user for easy identification, as in the case of Robertson screwdrivers, or it might be solely for appearance.
2. Have each pupil select a simple object and explain or list the considerations which might have caused the designer to select the shape, size, colour, finish and materials for its manufacture. These lists should be examined and amended after each of the programs is viewed.

SUGGESTED POST-VIEWING ACTIVITIES

1. Re-examine the object (the screwdriver), and through discussion enlarge upon those design considerations discussed prior to viewing the program. Discuss the use of models and prototypes. Question the value of field research studies.

   Question the reason sandcasting was used to produce the prototype engine parts rather than die-casting.
2. If possible, borrow a chain-saw and have the students handle it. Let them decide whether it meets the requirements outlined in the program.
3. Emphasize through discussion that while the chain-saw is the object of the program's investigation, the principles involved can be applied in varying degrees to any manufactured product.

PROGRAM 27

MATERIALS

The purpose of this program is to examine some of the materials used in the manufacture of a product, with the chain-saw serving as the example to explain why certain materials are used for particular parts.

PROGRAM CONTENT

The engineer chooses aluminum for the engine cylinder and piston because of its lightness and good heat transference properties. He selects steel forgings for the crankshaft and connecting rod where wear resistance and strength are important. Magnesium is used for all housings because of its relative strength and light weight. Because magnesium is highly reactive, all steel fastenings used must be cadmium or zinc-plated to reduce the galvanic potential and thus electrolytic corrosion. Heavy wear and its unusual shape dictate the use of a steel investment casting for the sprocket. The chain bar is made of steel which is surface hardened to improve its wear characteristics. The chain cutter links are made from nickel steel to provide good impact strength at low temperatures.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Review program twenty-six to examine the requirements of the chain-saw operator. Question how resistance to wear, heat and corrosion might be accomplished through the choice of materials.
2. Consider any object to ascertain why various parts are of different materials.
3. Question the class as to their possible choice of materials for the chain-saw and why. Possibly list materials on chalkboard.

SUGGESTED POST-VIEWING ACTIVITIES

1. Compare the materials selected by the engineers for the chain-saw with those selected by the class.
2. Discuss possible alternative materials for various parts, e.g. plastics or moulded fibreglass to replace magnesium housings. High impact plastics have been used in housings for hand-power drills, sabre saws, routers, etc.
3. Enlarge upon processes introduced in connection with materials used. Examples:

   a. steel investment castings

   b. heat treatment

   c. resistance heating

   d. forging
4. Explain fully the terms galvanic scale, galvanic cell, electrolytic corrosion.
5. Expand on chrome, zinc and cadmium plating.
6. Have each student explain why particular materials might be used for the various components of the simple object they selected for study prior to program twenty-six.

PROGRAM 28

PRODUCTION METHODS

The purpose of this program is to introduce several basic production processes which, although applied to the production of the chain-saw in this program, are fundamental production methods, widely used to produce fabricated products.

PROGRAM CONTENT

The major lightweight aluminum and magnesium components of the chain-saw are die-cast. Molten magnesium presents some problems in handling, since it tends to flash and burn when exposed to air. Magnesium chloride flux is floated on the surface of the molten magnesium to prevent this. Magnesium presents some machining problems. Since it is a naturally abrasive material with poor thermal conductivity, it causes excessive tool wear. Injection moulding is used to produce small parts from thermal plastics. The chain bar of the saw is a steel laminate copper brazed together in a controlled atmosphere furnace. An overlay of a hard material is welded to the chain bar nose to reduce wear. Chain cutters are stamped out on presses as chain links. The rivets for the chain are produced on automatic screw machines. Chains are hand-assembled. The engine cylinder bore is chrome-plated to provide a hard-wearing surface. Final assembly and painting operations are carried out after the engines are bench tested.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Consider the production methods that might be used to produce the simple object the pupils selected for study prior to program twenty-six.
2. Consider the production methods which might be used to produce any common manufactured object.
3. Consider the production methods which might be used to produce the components of the chain-saw. List these on the chalkboard.

SUGGESTED POST-VIEWING ACTIVITIES

1. Compare the actual methods used to produce the chain-saw with those suggested by the students prior to the program.
2. Discuss alternative methods that might have been used to produce chain-saw components. Emphasis should be placed on ease of handling, minimum scrap, and the effect on choice of process of the number of parts required.
3. Discuss in depth the die-casting process.
4. Possibly compare the copper brazing process with silver soldering in a controlled atmosphere furnace. (Note the extreme temperature of 2050°F for copper brazing).
5. Discuss the automatic screw machine.
6. Question or discuss the necessity of using a high nickel content steel for chain-cutters.
7. Discuss in depth the injection-moulding of thermal plastics.

PROGRAM 29

QUALITY CONTROL

The purpose of this program is to explain the concept of quality control, which aims at establishing and maintaining product quality and preventing defects in the manufacturing cycle, as opposed to the concept of inspection of the finished product. Inspection is not quality control. Procedures used by inspection on the plant floor may be instituted on the recommendations of the quality control department, but the quality control department is independent of production.

PROGRAM CONTENT

In the plant, checks aimed at quality control begin with raw material. Steel and other materials must be checked to ensure that they meet the designer's specifications. Components purchased outside must be accompanied by a certificate from the manufacturer guaranteeing quality equal to or above ordering specifications. Inspections are carried out on a sampling basis worked out by the quality control department. During production, floor inspectors check the operators' work to ensure that production standards are being met. A number of destructive tests are carried out on components at various stages of production by the quality control department. The metallurgist controls plating solutions and advises the heat treatment department on any necessary modifications to the heat treatment cycle. Quality control carries out exhaustive field tests on the product. Following field tests, the tested saws are stripped down to measure wear on components under field conditions. From these tests the quality control department is able to recommend design changes to improve the product.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Introduce the concept of quality control of raw materials by examining a simple object, perhaps the screw-driver, and asking the class how they might be certain the steel for the blade was the correct alloy. Consider a guarantee from the supplier as opposed to actual testing.
2. Introduce the concept of inspection, using measuring tools and comparison guages. The quality standards are established by the quality control department.
3. Identify some of the gauging methods used on the production of the chain-saw.
4. Explain the difference between destructive and non-destructive tests.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the importance of quality control operations as applied to design, materials and production processes. Perhaps assign a research report on the topic.
2. Assign an essay on the quality control operations carried out by a local manufacturer.

3. Discuss the relative merits of gauges and measuring tools for the efficient inspection of finished parts.

4. Discuss the relative merits of a sampling quality audit and a percentage check of parts.

PROGRAM 30

MACHINES FOR TODAY AND TOMORROW

The purpose of this program is to introduce a number of new manufacturing processes in use on a limited basis today, but which may become the fundamental processes of the future. Numerical control of machine tools is also introduced.

PROGRAM CONTENT

The program opens with a sequence devoted to the examination of the powder metallurgy process. The parts are shown being compacted of powdered metals in closed dies to form briquettes. The sintering process is shown, wherein the compacted powders are fused into solid metal in high temperature controlled atmosphere furnaces.

The introduction to powder metallurgy shows the necessity of quality cavity dies. Conventional machining processes are still used to produce some dies, but this program introduces some of the newer non-traditional machining processes.

Electric discharge machining, sometimes called "electrospark machining" or "spark erosion", is shown in some detail.

Other non-traditional machining methods such as abrasive jet machining, ultra-sonic machining, and laser-beam machining are given a more cursory treatment.

Numerical control of machine tools is explained in a simple manner. Emphasis is on the paper tape control system.

Closed-circuit television is mentioned as a means of examining operations on large parts or in hazardous locations.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss with the class some of the changes in materials and processes which have been introduced in the production of manufactured parts over the years. Select a product which has changed radically — a milk container, for example: from glass to plastics or cardboard container.

2. Discuss the difficulties which are encountered in the production of high-quality cavity dies by traditional machining processes.

3. Question the class to obtain a list of any new manufacturing processes they may have encountered in their reading.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the powder metallurgy process. Possibly assign a research report on the topic.

2. Expand on any of the following non-traditional machining processes:
   a. Electric Discharge Machining (EDM)
   b. Abrasive Jet Machining (AJM)
   c. Ultra-Sonic Machining (USM)
   d. Electrochemical Machining (ECM)
   e. Laser Beam Machining (LBM)

Note: An excellent reference manual, "Non-Traditional Machining Processes", has been published by the American Society of Tool and Manufacturing Engineers, Dearborn, Michigan.

SCIENCE, TECHNOLOGY AND TRADES
Senior Division
30 programs, 20 minutes each

Prog. No.	CBC 9:10-9:30	CBLT 9:40-10:00	CHCH 9:45-10:05	CKCO 9:30-9:50	CJOH 9:40-10:00	CBOT 9:10-9:30	CKLW 10:00-10:20
1	OCT. 15	same dates as	OCT. 16	same dates as	same dates as	same dates as	OCT. 23
2	OCT. 22	CBC	OCT. 23	CHCH	CHCH	CBC	OCT. 30
3	OCT. 29		OCT. 30				NOV. 6
4	NOV. 5		NOV. 6				NOV. 13
5	NOV. 12		NOV. 13				NOV. 20
6	NOV. 19		NOV. 20				NOV. 27
7	NOV. 26		NOV. 27		9:15		DEC. 4
8	DEC. 3		DEC. 4		9:15		DEC. 11
9	DEC. 10		DEC. 11		9:15		DEC. 18
10	DEC. 17		DEC. 18		9:15		JAN. 8
11	JAN. 7		JAN. 8				JAN. 15
12	JAN. 14		JAN. 15				JAN. 22
13	JAN. 21		JAN. 22				JAN. 29
14	JAN. 28		JAN. 29				FEB. 5
15	FEB. 4		FEB. 5				FEB. 12
16	FEB. 11		FEB. 12				FEB. 19
17	FEB. 18		FEB. 19				FEB. 26
18	FEB. 25		FEB. 26				MAR. 5
19	MAR. 4		MAR. 5				MAR. 12
20	MAR. 11		MAR. 12				MAR. 26
21	MAR. 25		MAR. 26				APR. 2
22	APR. 1		APR. 2				APR. 9
23	APR. 8		APR. 9				APR. 16
24	APR. 15		APR. 16 – 9:40-10:00				APR. 23
25	APR. 22		APR. 23 – 9:40-10:00				APR. 30
26	APR. 29		APR. 30 – 9:40-10:00				MAY 7
27	MAY 6		MAY 7 – 9:40-10:00				MAY 14
28	MAY 13		MAY 14 – 9:40-10:00				MAY 21
29	MAY 20		MAY 21 – 9:40-10:00				MAY 28
30	MAY 27		MAY 28 – 9:40-10:00				JUNE 4

SCIENCE, TECHNOLOGY AND TRADES